

## DEVICE HOUSING RESPONSIVE TO AN ENVIRONMENTAL STIMULUS

### Background of the Invention

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#### Field of the Invention

This invention relates in general to device housings and in particular to device housings whose appearance is responsive to environmental stimuli.

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#### Description of the Related Art

Housings for portable electronic devices are well known in the art. The role of a housing in a portable electronic device primarily includes covering, protecting and supporting the internal components encased within. The housing is adapted to provide a particular appearance by means of its molded contour, texture, or color. Typically, a conventional housing of a portable electronic device is standard in appearance and configuration. Minimal variation has conventionally been possible.

Furthermore, conventional portable electronic devices do not provide many options for a device user to alter the appearance of the portable electronic device once manufactured. Accessories such as device cases do provide some appearance differentiation, however, they tend to add size and weight to the portable device while providing a limited effect on the overall appearance.

Differentiating the appearance of individual portable electronic devices has become an important requirement for the customer, the manufacturer, and the distributor of such devices. Customers desire a unique appearance to satisfy their tastes and preferences. Customers further desire the ability to change the appearance  
5 of their portable electronic device for variety; and to match their moods, environment etc. Manufacturers desire a unique appearance to provide variety to their customers and to distinguish their products from competitor's products. Distributors desire a unique appearance to distinguish their product in the marketplace and to promote their brand name.

10 To provide product differentiation, manufacturers of portable electronic devices provide adhesive attached labels having different legends and appearances. Being adhesively attached, these labels offer a one-time option for the device user to choose a visual appearance for the exterior of the portable electronic device.

Some device manufacturers now offer interchangeable covers to provide  
15 customizable decorative ornaments for a portable electronic device. One example can be found in United States patent number 5,745,566, issued April 28, 1998 to Petrella et al. and titled "Portable Communication Device Having Removable Escutcheon Elements" which is assigned to the assignee of the present invention, and which is incorporated by reference herein. A benefit of these interchangeable covers is the  
20 additional protection they provide for the electronics contained within. A device user can easily change the device appearance with these customizable covers, typically available in an assortment of colors and patterns.

Similarly, some device manufacturers offer interchangeable faceplates accommodating differing sizes, shapes, and locations of buttons and displays of the portable electronic device. One example can be found in United States patent number 5,884,772, issued March 23, 1999 to Floyd et al. and titled "Electronic Device Having

5 Multiple User Interface Configurations" which is assigned to the assignee of the present invention, and which is incorporated by reference herein. Utilization of such faceplates provides flexibility and manufacturing cost reductions, however, the appearance of the portable electronic device remains fixed for the device user.

One drawback of both interchangeable covers and interchangeable faceplates

10 is that only one cover or faceplate and associated appearance applies. The device user physically removes one cover or faceplate and replaces it with another to provide a new appearance. Further, both interchangeable covers and interchangeable faceplates are inherently insecure in attachment to the portable electronic device, and are subject to loosening and detaching when jarred or dropped.

15 What is needed is a housing for a portable electronic device capable of providing a multiplicity of appearances with minimal user intervention and minimal additional components.

### **Brief Description of the Drawings**

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The present invention will be described by way of exemplary embodiments, but not limitations, illustrated in the accompanying drawings in which like references denote similar elements, and in which:

FIG. 1 is an illustration of a portable electronic device;

FIG. 2 is an exploded view of the portable electronic device of FIG. 1 in accordance with a preferred embodiment of the present invention;

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FIGs. 3 to 5 are illustrations of various embodiments of the portable electronic device of FIG. 1 in accordance with a preferred embodiment of the present invention; and

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FIG. 6 is a cross sectional view of a housing for use in the portable electronic device of FIGs. 1-5 in accordance with a preferred embodiment of the present invention.

**Detailed Description Of The Preferred Embodiment(s)**

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As required, detailed embodiments of the present invention are disclosed herein; however, it is to be understood that the disclosed embodiments are merely exemplary of the invention, which may be embodied in various forms. Therefore, specific structural and functional details disclosed herein are not to be interpreted as limiting, but merely as a basis for the claims and as a representative basis for teaching one skilled in the art to variously employ the present invention in virtually any appropriately detailed structure. Further, the terms and phrases used herein are not

intended to be limiting; but rather, to provide an understandable description of the invention.

Referring to FIG. 1, a portable electronic device **10** is illustrated. The portable electronic device **10** includes a housing **12** having an outer visible surface **14**. The housing **12** is preferably manufactured by a plastic injection molding technique as is well known in the art. By way of example, the preferred embodiment of the present invention is described in relation to a fixed housing such as the housing **12** of FIG. 1; however, it will be appreciated by one of ordinary skill in the art that the present invention is similarly applicable to a removable housing accessory such as the removable faceplate described in United States patent number 5,884,772, issued March 23, 1999 to Floyd et al. and titled "Electronic Device Having Multiple User Interface Configurations" which is assigned to the assignee of the present invention, and which is incorporated by reference herein. Similarly, the present invention is equally applicable to interchangeable covers for housings such as described in United States patent number 5,745,566, issued April 28, 1998 to Petrella et al. and titled "Portable Communication Device Having Removable Escutcheon Elements" which is assigned to the assignee of the present invention, and which is incorporated by reference herein.

Preferably, in accordance with the present invention, the outer visible surface is composed of an appearance changing substance. The appearance changing substance provides a means by which the physical environment of the portable electronic device **10** or external physical environment stimuli causes a change to the decorative appearance of the outer visible surface **14** of the housing **12**. The appearance

changing substance for example, can be a color changing substance, a pattern  
changing substance, an illumination producing substance, a shape changing substance,  
and a sensory producing substance or any combination therein. It will be appreciated  
by one of ordinary skill in the art that the appearance changing substance can be any  
5 of those substances mentioned herein or an equivalent.

When the appearance changing substance is a sensory producing substance, it  
can be a thermal producing substance, a vibration producing substance, and a haptic  
producing substance, or any combination therein. For example, the appearance  
changing substance can cause the housing 12 to interact with the muscles and tendons  
10 that give the human a sensation of a force being applied. Similarly, the housing 12  
can interact with the nerve endings in the skin that indicate heat, pressure, and texture.  
It will be appreciated by one of ordinary skill in the art that the sensory producing  
substance can be any of those substances mentioned herein or an equivalent.

The appearance changing substance for example can utilize thermo-chromic  
15 pigments whereby heat results in changing colors. The thermal change can be due to a  
hot environment or the body heat of the device user. Specifically, the appearance  
changing substance can be composed of thermotropic liquid crystals. These liquid  
crystal molecules can change position, or twist, according to changes in temperature.  
This change in molecular structure affects the wavelengths of light that are absorbed  
20 or reflected by the liquid. For example, as the temperature increases, the liquid crystal  
molecules twist in one direction. This twist causes the liquid crystal substance to  
absorb more of the red and green portions of the visible light, and reflect the blue part.  
The result is that the housing 12 appears to be dark blue. When the temperature

decreases, the molecules twist in the other direction, and reflect a different portion of the spectrum, causing the housing **12** to appear as a different color. It will be appreciated by one of ordinary skill in the art that, alternatively, the appearance changing substance can be a leuco dye rather than a liquid crystal, or an equivalent

5 thermochromic technology.

As another example, the appearance changing substance can be ultraviolet light pigments causing a decorative and/or informative response to ultraviolet light. When the portable electronic device **10** is exposed to sunlight or a specific wavelength of ultraviolet light, the housing **12** can change appearance (color, shape, pattern, etc.).

10 This could be for decorative purposes, for example, to change the color of the housing **12** when outdoors.

Each of the appearance changing substances, in accordance with a preferred embodiment of the present invention, is responsive to an environmental stimulus. The environmental stimulus, for example, can be an acoustic stimulus, a thermal

15 stimulus, an electrical stimulus, an electromagnetic stimulus, a mechanical stimulus, an olfactory stimulus, or any combination thereof. It will be appreciated by one of ordinary skill in the art that the environmental stimulus can be any of those stimuli mentioned herein or an equivalent. Further, it will be appreciated by one of ordinary skill in the art that the environmental stimulus can be generated internally or

20 externally to the portable electronic device **10**. For example, environmental vibrations, noise, music, sunlight, body heat, etc. emanating from outside of the device would encounter the housing **12** of the portable electronic device **10** and result in changing its appearance in a decorative or informative manner.

An electrical stimulus can include a communication message transmitted to the portable electrical device **10** by a service provider as is well known in the art. Further, an electrical stimulus can included a user input to the portable electronic device **10** such as a device user pressing a button or series of buttons on the portable electronic  
5 device.

The environmental stimulus, in accordance with the present invention, can be automatically generated as a natural occurrence, can be manually generated, or any combination thereof. For example, the environmental stimulus can be initiated by the device user in response to the device user's desire for a change in the appearance of  
10 the portable electronic device **10**.

In one embodiment, the sensitivity of the appearance changing substance can be adjusted or turned on or off. For example, the portable electronic device **10** can include manual sensitivity switches or software algorithms allow the device user to adjust the sensitivity of the appearance changing substance as desired. Similarly, the  
15 response of the appearance changing substance can be customized by the device user or selected from a plurality of responses. Further, in accordance with the present invention, the response of the appearance changing substance can be dynamically controlled either by a processor internal to the portable electronic device **10**, a computer external to the portable electronic device **10**, via receipt of a communication  
20 message either wirelessly or through a wired line, or any combination or equivalent therein. Dynamically controlling the response of the appearance changing substance provides a method for animations, messages, user customizable looks, and the like.



FIG. 2 is an exploded view of the portable electronic device **10** of FIG. 1 in accordance with a preferred embodiment of the present invention. As illustrated in FIG. 2, the portable electronic device **10** includes a plurality of internal components **16**. The housing **12** encases the plurality of internal components **16**, providing

5 covering, protection and structural support. Preferably, and in accordance with the present invention, the plurality of internal components **16** generates an environmental stimulus in which the outer visible surface **14** of the housing **12** responds. For example, light from keypads or displays, vibrations from alerting mechanisms, or sound from speakers or transducers can generate environmental stimuli in which the

10 appearance changing substance responds. It will be appreciated by one of ordinary skill in the art that the internal environmental stimulus can be any of those mentioned herein or an equivalent.

As illustrated in FIG. 2, the portable electronic device **10** further includes at least one resistive element **18**. Preferably, the at least one resistive element **18** is

15 energized to generate a thermal stimulus in which the outer visible surface **14** of the housing **12** responds. The appearance of the outer visible surface **14**, for example, can be actively controlled by mating the at least one resistive element **18** to the housing **12** and selectively sending current by the plurality of internal components **16** to the at least one resistive element **18** to produce a thermal stimulus and generate a response

20 by the appearance changing substance to change the appearance of the outer visible surface **14**.

FIG. 3 is an illustration of one embodiment of the portable electronic device **10** of FIGs. 1 and 2 in accordance with a preferred embodiment of the present invention.

As illustrated in FIG. 3, the outer visible surface **14** of the housing **12** includes a shape element **22**.

As illustrated in FIG. 4, the shape element **22** can be an at least one identification information **24**. For example, the at least one identification information **24** can be an identification data, an identification code, an identification pattern, an identification image, or any combination therein. It will be appreciated by one of ordinary skill in the art that the at least one identification information **24** can be any of the identification information mentioned herein or an equivalent. In accordance with the present invention, the identification information **24** can become visible, for example, when exposed to ultraviolet light for anti-counterfeiting and security measures.

As illustrated in FIG. 5, the shape element **22** can be an environment index gauge **26**. For example, the environment index gauge **26** can be an ultraviolet light gauge, a temperature gauge, an acoustic gauge, or any combination therein. It will be appreciated by one of ordinary skill in the art that the environment index gauge **26** can be any of the gauges mentioned herein or an equivalent. The environment index gauge **26** provides potential environmental warnings to the device user to aid in protection of the device user from harmful environmental factors.

Referring to FIGs. 3 to 5, preferably, in accordance with the present invention, the shape element **22** is composed of an appearance changing substance. The appearance changing substance for example, can be a color changing substance, a pattern changing substance, an illumination producing substance, a shape changing substance, and a sensory producing substance or any combination therein. It will be

appreciated by one of ordinary skill in the art that the appearance changing substance can be any of those substances mentioned herein or an equivalent.

The sensory producing substance can be a thermal producing substance, a vibration producing substance, and a haptic producing substance, or any combination  
5 therein. It will be appreciated by one of ordinary skill in the art that the sensory producing substance can be any of those substances mentioned herein or an equivalent.

Each of the appearance changing substances, in accordance with a preferred embodiment of the present invention, is responsive to an environmental stimulus.  
10 The environmental stimulus, for example, can be an acoustic stimulus, a thermal stimulus, an electrical stimulus, an electromagnetic stimulus, a mechanical stimulus, an olfactory stimulus, or any combination thereof. It will be appreciated by one of ordinary skill in the art that the environmental stimulus can be any of those substances mentioned herein or an equivalent. For example, the shape element **22** can be located  
15 near the surface of the housing **12** and act as a heat sink.

In one embodiment of the present invention, the shape element **22** with the appearance changing substance becomes visible in response to the environmental stimulus. It will be appreciated by one of ordinary skill in the art that alternatively the shape element **22** with the appearance changing substance becomes invisible in  
20 response to the environmental stimulus.

In one embodiment of the present invention, the plurality of internal components **16** generates an environmental stimulus in which the shape element **22** responds. Alternatively, the at least one resistive element **18** is energized to generate

a thermal stimulus in which the shape element **22** of the outer visible surface **14** of the housing **12** responds.

As an example, the shape element **22** can be composed of a color changing ink. The color changing ink can change from one color to another, or alternatively  
5 can change from colored to clear. The color changing ink can be thermochromic, which change color in response to temperature fluctuations, or photochromic, which respond to variations in exposure to UV light (primarily sunlight). Both materials are reversible and will change colors over and over again with the appropriate exposure. Alternatively, the color changing ink can be hydrochromic, which changes color in  
10 response to water, or piezochromic, which changes color in response to pressure. Further, the color changing ink can be electrochromic, which changes color in response to the presence of a voltage.

In one embodiment, the shape element **22** is composed of electronic ink. The electronic ink is preferably comprised of a plurality of microcapsules, containing  
15 positively charged white particles and negatively charged black particles suspended in a clear ink. When a negative electric field is applied, the white particles move to the top of the microcapsule where they become visible to the user. This makes the surface appear white at that spot. At the same time, an opposite electric field pulls the black particles to the bottom of the microcapsules where they are hidden. By  
20 reversing the process, the black particles appear at the top of the microcapsule, making the surface appear dark at that spot.

FIG. **6** is a cross sectional view of one embodiment of the housing **12** of the portable electronic device **10** of FIGs. **1-5** in accordance with the present invention.

As illustrated, the housing **12** is composed of an outer layer **28**, an inner layer **30**, and an enclosed volume **32** arranged between the outer layer **28** and the inner layer **30**.

Preferably, the outer layer **28** preferably is composed of transparent materials to provide a visual path to the enclosed volume **32**. The inner layer **30** can be either

5 transparent or opaque in accordance with the present invention.

In one embodiment, the enclosed volume **32** comprises a plurality of fiber optics such as described in United States Patent 5,087,906, issued February 11, 1992 to Eaton et al and titled "Selective Call Receiver Having a Light Channel for Providing a Visual Alert" which is assigned to the assignee of the present invention, and which is  
10 incorporated by reference herein. For example, the enclosed volume can include a light channel such as a fiber optic cable. The light channel can comprise a variety of sizes and lengths without deviating from the intent of the invention. The light channel is illuminated using a light source positioned at one end of the light channel. The light source then can travel at a predetermined wavelength(s) to maximize diffusion of  
15 the light source.

The enclosed volume **32** preferably holds at least one fluid **34** and at least one decorative substance **36**. In one embodiment, for example, the enclosed volume **32** contains multiple colored fluids. Alternatively, the enclosed volume can contain two or more immiscible liquids to create wave effects or any other liquid based dynamic  
20 decorating technique. The at least one decorative substance **36** can be, for example, a colored dye, a plurality of pearlescent particles, a plurality of light reflecting particles, a plurality of bubbles, at least one free floating solid shape, and at least one decorative substance comprises an immiscible liquid, or any combination therein. It will be

appreciated by one of ordinary skill in the art that the at least one decorative substance **36** can be any of the substances mentioned herein or an equivalent.

The at least one decorative substance **36** in one embodiment is characterized by a decorative substance viscosity and the at least one fluid **34** is characterized by a fluid viscosity. Preferably, the decorative substance viscosity differs from the fluid viscosity. It will be appreciated by one of ordinary skill in the art that alternatively the decorative substance viscosity and the fluid viscosity can be substantially equivalent.

The elements of the enclosed volume, in accordance with the present invention, respond to one or more environmental stimuli. For example, in one embodiment of the present invention, the at least one decorative substance **36** moves in relation to the at least one fluid **34** in response to an environmental stimulus. The environmental stimulus can be, for example, an acoustic stimulus, a thermal stimulus, an ultraviolet light stimulus, an electromagnetic stimulus, a mechanical stimulus, or any combination thereof. It will be appreciated by one of ordinary skill in the art that the environmental stimulus can be any of the stimuli mentioned herein or an equivalent.

In one embodiment, the plurality of internal components **16** of the portable electronic device **10** generates the environmental stimulus. For example, heat, light, sound, vibration, electromagnetic fields, electrical voltage, or electrical current produced by the plurality of internal components **16** during product operation can cause special effects through the response of the elements of the enclosed volume.

For example, when the environmental stimulus is a light, the light interacts with the at least one decorative substance **36** to create a plurality of visual effects.

Further, the light further can interact with the at least one fluid **34** to create a second plurality of visual effects.

Although the invention has been described in terms of preferred embodiments, it will be obvious to those skilled in the art that various alterations and modifications  
5 may be made without departing from the invention. Accordingly, it is intended that all such alterations and modifications be considered as within the spirit and scope of the invention as defined by the appended claims.

What is claimed is:

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